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Fifteen-Year Growth of Six Planted Hardwood Species on Sharkey Clay Soil

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SUMMARY

Six hardwood species planted on Sharkey clay soil that had been disked the first 5 years for weed control were significantly taller at age 5 when compared to species grown on mowed sites. By age 15, there were no differences in heights within species except for sweet pecan. Average heights by species at age 15 were: cottonwood (*Populus deltoides* Bartr. ex Marsh.), 60 feet; sycamore (*Platanus occidentalis* L.), 38 feet; green ash (*Fraxinus pennsylvanica* Marsh.), 36 feet; sweetgum (*Liquidambar styraciflua* L.), 30 feet; Nuttall oak (*Quercus nuttallii* Palmer), 27 feet; and sweet pecan (*Carya illinoensis* (Wangenh.) K. Koch), 19 feet.

Additional keywords: *Populus deltoides, Platanus occidentalis, Fraxinus pennsylvanica, Liquidambar styraciflua, Quercus nuttallii, Carya illinoensis.*

INTRODUCTION

Planting hardwood species is an option for clay soils being withdrawn from agricultural production in the Midsouth. Clearing and planting of slackwater sites can also be considered as a method for regenerating cutover and depleted stands and for introducing desired species on given sites. Yields on clay soils are inherently less than yields on medium textured soils and therefore provide poorer economic returns. Cultural treatments that would increase tree growth would be beneficial. This note provides growth information through 15 years for hardwood plantings where some weed control by disking or mowing was maintained yearly for 10 years and where selective thinning after 5 years doubled the original planting spacing for five of the six species in the study.

METHODS

The study was located on the Delta Experimental Forest (DEF) near Stoneville, Mississippi. Planting was in 1971 after the slackwater area had been cleared of trees and the site raked and disked. The soil is Sharkey clay.

Species planted were cottonwood (CW—*Populus deltoides* Bartr. ex Marsh.), sycamore (SY—*Platanus occidentalis* L.), green ash (GA—*Fraxinus pennsylvanica* Marsh.), sweetgum (SG—*Liquidambar styraciflua* L.), Nuttall oak (NO—*Quercus nuttallii* Palmer), and sweet pecan (SP—*Carya illinoensis* (Wangenh.) K. Koch). Estimated midrange site indices for these species on Sharkey clay are 95 feet for CW (30 years); 90 feet for SY, SG, and NO; 85 feet for GA; and 80 feet for SP (all at 50 years) (Broadfoot 1976).

One-year-old nursery grown seedlings or 20-inch-long CW cuttings were planted in a split-plot design with six blocks (replications). Species subplots consisted of a 4-column by 6-row planting (24 trees) on a 10-foot spacing. Each CW row contained a separate Stoneville clone, either clone 66, 67, 78, 82, 213, or 244. Plots were mowed or disked three to five times annually the first 5 years.

After the 5th year, species subplots with 60 percent or more survival based on trees >4.5 feet tall were thinned to six trees each, or an equivalent 20- by 20-foot spacing. Consequently, SG and NO mowed plots and SP mowed and disked plots were not thinned because of slow height growth. For thinning, subplots were subdivided into squares of four trees each, and one tree per square was left to maintain spacing over a subplot. Mowing or disking treatments, one to three times annually, for years 6 to 10 were randomly assigned to whole blocks to

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compare effects of continued or switched cultural treatments on tree growth. But since there was so little difference between mowing and disking the second 5 years (Krinard and Kennedy 1983), results are discussed relative to the first 5-year weed control treatments.

Data presented are 5-, 10-, and 15-year measurements of total height and d.b.h. and 15-year survival of unthinned plots. For comparison with thinned plots, the six largest trees on unthinned plots were selected after the 15th year in the same manner as thinning techniques were applied after 5 years.

RESULTS

At age 15, based on 109 trees per acre and averaged over all six species, trees on plots disked the first 5 years were significantly taller and larger in d.b.h. than trees on plots that had been mowed.[1] However, for practical purposes the differences were unimportant as they only amounted to 1.3 feet in height and 0.6 inch in diameter. For height, by species, CW > SY = GA > SG > NO > SP, where CW was 22 feet taller than SY, SY was 8 feet taller than SG, SG was 3 feet taller than NO, and NO was 8 feet taller than SP. D.b.h. rankings among species were the same except that SG and NO did not differ. There was no cultural treatment by species interaction for either height or diameter.

[1]Error mean squares for analyses used in this note are given in Appendix, table 1.

Individual species analyses of variance for treatment effects were planned a priori regardless of overall F-test results, and the comparisons are presented in table 1. At age 5, d.b.h. and height of disked trees were significantly larger than mowed trees for all species tested. Diameter comparisons for SG, NO, and SP were not made because 25 to 94 percent of the mowed trees were not tall enough to have d.b.h. measurements.

At age 10, diameters and heights of both CW and GA did not differ by disking or mowing treatments, but differences were still detected for the other four species. By age 15, however, only SG diameters and SP heights and diameters differed by weed control treatments. Since the SG diameter comparison was between thinned and unthinned trees, a difference might be expected; however, diameters of NO trees did not differ even though thinned and unthinned trees were also compared.

Survival after 15 years on mowed SG and NO plots and disked SP plots ranged from 76 to 84 percent (table 2) and were within 1 percent of the survival at 5 years. Through the 5th year and beyond, a number of the mowed SP trees were dying back and subsequently root sprouting, so that the actual survival appeared to increase from 48 to 58 to 62 percent after 5, 10, and 15 years, respectively.

The maximum number of CW trees per clone that could have been selected for either cultural treatment after the 5th year was 12. In disk plots, the number of trees per clone selected varied from four (clones 78 and 82) to eight (clones 66 and 244); in mowed plots the number varied from two (clone 78) to nine (clone 67). The Friedman rank test did not indicate a difference in

Table 1.—*Average diameter and height by species, age, and first 5 years' cultural treatment for equivalent 20- by 20-foot spacing (109 trees per acre)*

	Cottonwood		Sycamore		Green ash		Sweetgum		Nuttall oak		Sweet pecan	
Age	D[1]	M[2]	D	M	D	M	D	M	D	M	D	M
	Diameter (inches)											
5	4.3*[3]	2.9*	3.0*	1.4*	2.4*	1.8*	1.2	---[4]	1.1	---	----	----
10	8.4	7.6	5.4*	4.4*	5.1	5.1	3.6*	2.4*	3.3*	2.2*	1.8*	0.8*
15	11.0	10.2	6.5	6.5	6.5	7.0	5.9*	4.7*	5.8	5.0	3.4*	2.2*
	Height (feet)											
5	26.9*	19.9*	20.6*	13.1*	17.9*	14.7*	10.4*	5.7*	10.0*	5.3*	4.4*	2.9*
10	48.7	46.4	30.4*	26.1*	29.6	27.8	21.8*	18.7*	19.1*	14.3*	13.0*	8.1*
15	60.4	59.6	37.7	38.8	36.3	36.4	30.6	29.6	28.2	26.1	21.7*	16.5*

[1]D = Disk.
[2]M = Mow.
[3]* = Means within same age and species significantly different at 0.05 level.
[4]--- = 25 to 94 percent of trees ≤4.5 feet in height.

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Table 2.—*Average 15-year survival, diameter, and height for unthinned plots by species and cultural treatment during first 5 years*

	Sweetgum	Nuttall oak	Sweet pecan	
	Mow	Mow	Disk	Mow
Survival *(percent)*	76	83	84	62
Diameter *(inches)*	4.2	4.0	2.5	1.7
Height *(feet)*	27.6	24.0	17.8	13.9

the number of trees selected per clone in either treatment. A completely random design was used to compare d.b.h. and heights of the CW clones at age 15 on disk and mow plots. Best height growth was by clones 66, 244, and 67, which averaged 66, 64, and 61 feet, respectively. The other three clones averaged 51 to 56 feet tall (table 3).

Table 3.—*Average diameters and heights at age 15 by cottonwood clones and weed control treatments*

	Disk		Mow	
Clone	D.b.h.	Height	D.b.h.	Height
	Inches	*Feet*	*Inches*	*Feet*
66	11.3	67a[1]	10.4ab	65a
67	10.4	61bc	9.6bc	61a
78	10.3	54d	7.6c	48b
82	10.5	58cd	9.3bc	55b
213	10.3	54d	10.0bc	55b
244	12.2	64ab	11.8a	64a

[1]Means within the same column followed by the same letter were not significantly different at the 0.05 level by Duncan's multiple range test; where no letters appear, overall test was not significant.

DISCUSSION

This study provided an example of relative growth rates among species over a 15-year period where there was some control of competition variables and where individual species competed only with themselves. Using average heights of combined mow and disk plots, and assigning a rating of 100 to CW because it was the fastest growing tree, other species, in the order SY, GA, SG, and NO, rated 72, 70, 34, and 33 at age 5; 59, 60, 43, and 35 at age 10; and 64, 61, 50, and 45 at age 15. Thus, SY and GA have generally been 60 to 70 percent as tall as CW, and SG and NO have increased from one-third to about one-half as tall as CW.

Although disking (when compared to mowing) was beneficial because of better growth and survival during the first 5 years of stand establishment, the effects were lost in the following 5 to 10 years. At least on Sharkey clay soil, there appear to be no growth benefits that will be maintained throughout a rotation. Disking provided better survival at age 5: 91 vs. 80 percent averaged over the six species. Survival differences between treatments within species other than SP varied from only 1 percent for GA to 12 percent for NO. Better survival provides more possibilities in thinning, but if thinnings have no commercial value, there appears to be little difference between disking and mowing at 10- by 10-foot spacings. Better survival would definitely be a factor at wider spacings, however. As the application of either operation requires the use of a tractor, the economics of the treatments appear similar, assuming equal site preparation requirements.

Where species had significant differences in diameters and heights at age 5 but none at age 15, obvious growth pattern differences had occurred between trees starting out under the two weed control systems. The most striking example was SY, which grew about 13 feet each 5-year period on mowed plots while trees on disked plots grew about 21, 10, and 7 feet over each of the same three periods. For all species, the height differences between the two treatments was less the last 5-year period than during the first 5-year period. The reason for the different growth patterns is not known. One speculation is that mowing, by controlling height of competing vegetation but not root development, may force the tree species into an eventual deeper or better rooting pattern, while disking provides a relatively competition-free root zone with the trees having a more shallow, less developed root system just beneath the disked area.

By thinning CW at age 5, a viable population was maintained, at least through 15 years. Other unthinned, or less severely thinned, CW plantings on the DEF have had high mortality, very weak crowns on the survivors, and no stems with a chance of becoming future crop trees. The only obvious advantage in starting with 10- by 10-foot spacings and thinning at age 5, as opposed to starting with 20- by 20-foot spacings with no thinning, is some choice in the selection of leave trees. However, given the poor utilization market for small trees now available, a 10- by 10-foot spacing with CW on clay soils appears too close.

Height growth over 15 years of the six CW clones in this planting showed a separation into two groups, with one group averaging about 54 feet and the other about 64 feet. Using Broadfoot's site index curves for natural stand CW (1960), those heights approximate 30-year site indices of 77 and 89 feet.

The heights of the tallest one-third of the mowed, unthinned SG and NO trees were within 1 or 2 feet of the same species in disk plots. But even at age 15, trees in mowed plots were too small for a commercial thinning. Height of the planted NO was similar to direct-seeded NO on another area of the DEF, which at age 15 produced 183 dominant/codominant trees per acre that averaged 26 feet tall.

The growth of SP is very slow on Sharkey clay soil. One possible reason for planting the species would be as a mast crop for wildlife, but it would be a very long-

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term proposition. A better alternative would be direct-seeded sawtooth oak (*Quercus acutissima* Carruth.), which in an adjoining area on the DEF averaged 4.0 inches in d.b.h. and 28 feet in height at 14 years, with 86 percent of the trees producing acorns (Francis and Johnson 1985).

The following information is available on planted species development on better sites through 15 years for comparison with the growth on Sharkey clay in this study. Dominant CW on silt loam soils averaged 96 to 104 feet in 15 years depending on spacing (Krinard and Johnson 1980); at age 6 dominants averaged approximately 64 feet, which exceeded 15-year-old CW growth on clay soil. Average heights at an equivalent 15-foot spacing, about 195 trees per acre, on medium-textured soils were 65 feet in 18 years for SG (Krinard and Johnson 1985)—vs. 37 feet in 18 years on the DEF—and 70 feet in 16 years for SY. These data indicate that clay soils, compared to medium-textured soils, were only 0.55 to 0.60 as productive for hardwood growth.

While all six species may be successfully planted, to do so only for timber production would not be a good economic investment because of slow growth (Anderson and Krinard 1985). Direct seeding of NO (Johnson 1981) to ensure an oak component, together with natural regeneration, could be the best practical regeneration approach on clay soils.

LITERATURE CITED

Anderson, Walter C.; Krinard, Roger M. 1985. The investment potential of cottonwood sawtimber plantations. In: Shoulders, Eugene, ed. Proceedings of the 3d biennial southern silvicultural research conference; 1984 November 7-8; Atlanta, GA. Gen. Tech. Rep. SO-54. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 190–197.

Broadfoot, W. M. 1960. Field guide for evaluating cottonwood sites. Occas. Pap. 178. New Orleans, LA; U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 6 p.

Broadfoot, Walter M. 1976. Hardwood suitability for and properties of important Midsouth soils. Res. Pap. SO-127. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 84 p.

Francis, John K.; Johnson, Robert L. 1985. Direct-seeded sawtooth oaks (*Quercus acutissima* Carruth.) show rapid growth on diverse sites. Tree Planters' Notes. 36(3): 3–5.

Johnson, R. L. 1981. Oak seeding—it can work. Southern Journal of Applied Forestry. 5(1): 28–33.

Krinard, R. M.; Johnson, R. L. 1980. Fifteen years of cottonwood plantation growth and yield. Southern Journal of Applied Forestry. 4(4): 180–185.

Krinard, Roger M.; Johnson, Robert L. 1985. Eighteen-year development of sweetgum (*Liquidambar styraciflua* L.) plantings on two sites. Tree Planters' Notes. 36(3): 6–8.

Krinard, Roger M.; Kennedy, Harvey E., Jr. 1983. Ten-year growth of five planted hardwood species with mechanical weed control on Sharkey clay soil. Res. Note SO-303. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 4 p.

Appendix

Table 1.—*Error mean squares for analyses*

		Age 15		Age 10		Age 5	
	Df[1]	Height	Diameter	Height	Diameter	Height	Diameter
1. Page 2							
Disk vs. mow	5	3.61	0.35	.....	.....	.....	.....
Six species	50	9.38	0.67	.....	.....	.....	.....
2. Table 2							
Cottonwood	5	42.29	2.11	32.31	1.14	6.77	0.46
Sycamore	5	3.72	0.35	0.84	0.06	2.21	0.09
Green ash	5	3.90	0.54	3.04	0.30	2.05	0.10
Sweetgum	5	4.17	0.26	3.67	0.19	2.03	.....
Nuttall oak	5	6.33	0.43	4.35	0.32	1.96	.....
Sweet pecan	5	2.41	0.28	3.30	0.14	0.56	.....
3. Tabe 3							
Cottonwood							
clones, disk	30	19.91	1.73	.....	.....	.....	.....
clones, mow	29	30.91	2.32	.....	.....	.....	.....

[1]Error degrees of freedom.

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